

# How to Use Trichlorethylene Solvents

VERY little has appeared in print about trichlorethylene. In various forms it is being used by numerous plants in this country and Europe, by the army and navy. Yet in the plants where it is used very few foremen know what it is or how to handle it. The heads of departments know that it is better than the old soda kettle method of cleaning metal, have heard that it is dangerous to the health of the operator, that it is hard to keep operators on the job, but haven't read anything about it and know little authentic about it except what is seen casually as they go down the alley in the plant.

There are adequate, though generally antiquated, articles in chlorinated hydrocarbons in mechanical encyclopedias. Most of them are pre-war and out of date. The writer's practical experience with it has been entirely during this war period. It came fast. New data have not been compiled. Comparative information, which is needed, has not been made public, or at least is not generally known. The chemistry of it is fairly common knowledge, but the average shop superintendent and certainly the usual operator is not a chemist.

There is a bewildering confusion in the medical profession as to whether it is toxic, causes heart trouble, or has any permanently pernicious effect upon those who use it. Operators disagree and shops vary as to opinions and decisions. Salesmen even compete in arguments for their elimination of disagreeable effects, and advertisements have begun to recognize that there is an argument to be met. This article is not a chemical treatise or a medical examiner's report or an engineer's verdict. It is written

... Written by a shop man for shop men, this article describes solvent types of cleaning equipment, their use and maintenance. Proper utilization gives superior cleaning at less cost, with dangers inherent in handling this chemical reduced to a minimum.

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ten by an operator who has had about two years' experience on degreasers and is now in charge of all such operations in a machine tool plant flying two well-won "E" pennants. It is written at the request of plant superintendents for simple information. The writer has had practical experience, has read everything he can get his hands on concerning the job, has pumped chemists, doctors, professors and salesmen for detailed information. He had six weeks' hospitalization which may have been caused by contacts with these solvents. His hands are burned with it. One doctor told him that he was doing a sacrificial patriotic service to industry to operate with it. He has seen many operators come and go. He has tried to do a good job with it. Perhaps the present governmental limitation of its sales by 30 per cent will force the industry to change the product or find a substitute. For the present the industry has trichlorethylene to use. In a day laboring-man's language, what is it and how is it being used?

Like a good many of scientific ne-

cessities the first degreasers were used in Germany. They had to get a quicker and better cleaning job for materials that had gone to or through production lines. The Germans made the first trichlorethylene to meet this demand. Every piece of steel, except a few of the higher grades, has to be covered with some sort of grease that will prevent rust. This has to be removed before assembly. The old method was to use a soda kettle or a pail of kerosene and a rag. It was too slow, inefficient and a considerable fire hazard. Chemists worked for years to find a quick boiling solvent that would cut grease and dry immediately. Chlorinated hydrocarbons had been used for various cleaning jobs, and dry cleaning plants had developed their use in many of these jobs.

The first use of trichlorethylene in Germany was not highly successful. It did a good job on steel and the operators. It degreased both. Many operators died. The form of it developed in this country was a better product, purer and cleaner and less

dangerous. It was made non-inflammable by changing the flash point, and it was made safer. Individual companies, buying new trichlorethylene, added their own stabilizers and volatilizers. The result, sold under various trade names, is a solvent that boils twenty-four degrees quicker than water, is volatile (has the same chemical formula in its vapor or distilled form), is five and one-half times heavier than air, so normally stays down in the machine. It cuts most grease instantly, cleans adequately, and when properly handled causes no more trouble than is found in any other part of the factory.

About 1935 American companies that had been working on this problem for about 20 years began to produce machines to use this new solvent. Three types became common: immersion, vapor and spray. These today are found in various combinations, and in sizes varying from bench models to huge conveyors. These machines, with heating attachments, have compartments large enough to take baskets of work and yet small enough so as not to crowd the building. Each machine is a still, working over its own solvent for a clean dip, bath or spray.

In the vapor type machine the solvent is heated by either electric coils or steam. Steam is more easily controlled and cheaper if available the year around. The solvent boils at 86.7 deg. C., or 188.6 deg. F. Vapor from it rises in the tank. About two-thirds of the way up the tank are water coils or a water-jacket (a patented feature of one company.) The height of the vapor line is regulated by thermostats and the temperature of the water. When the vapor strikes the cool coils or water jacket it condenses and is returned eventually to the bottom of the tank. The baskets of work are dipped into the vapor. This clean vapor is from the solvent only. Pieces have no contact with anything else. The baskets may be small and hand-dipped, or they may be large and operated with an electric hoist. A spray hose may facilitate the work.

In the immersion type there are usually two dips after a vapor bath, one to cut the grease and the other for a final rinse. The immersion type is faster, as most pieces require only a 30 sec. dip and a quick rinse. It also penetrates holes that would be untouched with a spray. It is better for smaller parts.

The cost of degreasing has been cut in half in recent years. When original cost is compared with the cost of the old soda kettle it may seem

a luxury. But when the tremendous amount of work that these machines will do in a day is taken into account, and also the money and time involved in the old methods of hand cleaning, the saving is evident. Men on the assembly floor who used to hand-clean their own work in a pail almost doubled their assembled output with machine cleaning.

One expensive high grade steel piece valued at \$275 was protected with a special grease. It required 20 min. and a high priced grease remover to clean it. The machine did 20 pieces in 20 min. and did a more thorough job. Machines are built to take anything from minute parts to airplane wings, even with paint-dip and drying attachments. Companies are sold machines adapted to their jobs, and each machine is sized for certain weight limits per hour. This is not an argument for buying degreasers, for the government has recently said that there are enough in plants and forbids the companies manufacturing any more at present. This is just an explanation to aid in understanding what we have in operation now.

#### Is It Dangerous?

Is trichlorethylene a dangerous solvent to use? Of course anything might be dangerous under certain conditions. Can it be handled so that there is no danger at all? Perhaps not enough information is available to answer this question fully now. Even doctors disagree. The 53-gal. drums that bring it to the shop have labels with a toxic warning. Perhaps if there was no warning operators would be less careful.

Some plant doctors would put it out of the building. Some medical books analyze the known ills that come from it and believe there is no permanently harmful effect. One girl drank some by mistake, was given olive oil, and went to a dance that night. Some men have developed a "narcotic craving" for it. It gives them a cheap drunk.

One doctor in a very recent report told of using it as an anesthetic to cure severe headaches. It cured the headache, but the patient died of ventricular fibrillation. Several cases are known of deaths of operators of the conveyor type. They died of asphyxiation while within the machine working on repairs. It may have been the solvent that contracted the heart muscles until they acted singly instead of together and stopped the flow of blood. In one case the doctors believed the solvent harmed the heart so that the operator could not pass

Army or Navy physical examinations. There was one case of acute kidney and bladder stoppage that most likely would never have happened if the operator had been working in a hay field. These can be multiplied in each plant.

Careful diagnosis has not always been made. A company will transfer an operator from a degreaser job if he says it hurts his feet or prevents sleep. The word of the operator is accepted without much medical opinion. It is, of course, no secret that many people do not like the smell of it and say so violently. This is taken into large type in some advertising. Some men are allergic to it and feel sick to their stomach when near it, much as some are if they smell too much paint. One man said it gave him a quincy throat. Investigation said that he had been treated for such a throat condition years before. Yet the solvent may have aggravated an already unhealthy condition. Honest diagnosis is necessary and comparative information should be known.

Manufacturers, to be on the safe side, say it is toxic; therefore, it is wise to be careful. Companies do transfer operators from degreasing machines on complaint. Some give regular health examinations. They feel they must do it. Operators do get dizzy, and some do not like to work with it.

The trained operator knows what it is and how to handle it. Yet, in spite of caution, a gust of wind may blow the vapor at him and give him a dizzy, staggering, dozey feeling. His hands may be burned with it. He may splash it on his face or in his eyes. Usually a few minutes in the fresh air will clear the operator's head. He gets used to it, and when splashed by it generally will just stand still for a minute and let it evaporate. There is no after hurt. Most operators do not think that the effects from it are permanent. Even the one who had bladder trouble cleared it up in a few weeks. Like some other contacts, it may hit a weak spot. Some people, especially negroes, should not handle it at all.

The simple precautions are: Wear dry gloves, do not stand over the machine any more than is necessary, do not smoke over or near it, keep the vapor in the machine, and take time to dry off the work.

If machines are in proper condition and are properly used operators have very little trouble and learn to like their jobs as they become experts. Much of the bad odor attributed to it comes from burned oil. New smells usually require time to tolerate.

These solvents have high resistance to rust. They will clean even when dirty. They are fast and satisfactory when properly operated. The operator who is trained by his foreman, and experienced, knows that the heat of the vapor almost equals the heat of the boiling liquid. Therefore, he is careful. Hold a clean, dry hook in the vapor inside a degreaser and watch the distilled solvent run from it. Baskets must be raised or lowered slowly, about 9 to 12 ft. per min. Loads must be kept small. It saves time in bringing up the vapor level, and does not force the vapor out of the machine into the room. This is one of the simplest and most difficult tricks to teach new operators. If they take a little more time they save time. It means protection to them and less complaints from other machine operators in the same bay.

The same lesson applies to smoking. There is no danger as regards the solvent, as most of them have been made non-inflammable. A dip tank, which usually is a part of the operator's equipment, is filled with a greasy oil with a paraffin base which dries quickly and keeps pieces clean and rust free for the stockroom. This may be inflammable and necessitate special care. The attempts to find a very thin dip that is satisfactory, quick-drying, and would require no further degreasing before assembly is still one of the trade necessities and an unsolved goal of the oil companies.

To avoid all fire hazards and prevent harm to the operator, the customary warning is "No smoking in this restricted area." Usually the harm is not to the solvent, but to the operator. The fumes of the vapor combine with nicotine and produce a third acid which is harmful to the throat and lungs.

Most degreasing machines have been placed in factories as afterthoughts. Some corner that was unused, or some handy open space along the side of an alley has been cleared out and the degreaser installed. It may be that work benches or other machines are too near. It may be a draughty place where air currents will drive the vapor out into the room. Released vapor, being heavier than air, settles to the floor. A top ventilator is insufficient. Some factories put a case around the degreaser which will take off all fumes. Some have an especially air-conditioned room. This could be built easily even into older buildings. If the machine is sunk into a pit there must be a special floor blower. Home-made blowers to carry off the vapors have not been highly satisfactory. It is a

problem for the air conditioner, and since the average older factory hasn't taken this problem seriously, the situation for a degreasing operator is generally no worse than for the operator of other machines. Something like the electric precipitron should be in the plans for the future. It is an investment in economy as well as health, and ought to be compulsory.

Much of the trouble with degreasers has come from cheap, poorly paid help, untrained in caution, operating a machine they do not understand. Some of the trouble has been deliberate, done to get a transfer, or to get the machine moved to another part of the factory building. Most of this trouble can be prevented.

Gas masks may be necessary in rare instances. They are valueless unless they cover the eyes as well as the nose and throat. Most operators never wear them.

Some plants do not allow women operators on degreasing machines. In their monthly periods these solvents may affect some women much as paint does to a pregnant woman. With proper replacements some factories are operating as many as three-fourths of their degreasers with women. The usual operator has to do a great deal of lifting, in spite of the electric hoist, so that outside of departments cleaning small work such as die parts, a strong able-bodied man is usually required.

### Care and Caution

Degreasing problems came into factories so suddenly that little was done at first to unify the work or correct mistakes. About 1940 plant superintendents, at some machine tool show, saw a degreaser in operation for the first time and said that that was what they needed in their plant. It was ordered, placed in an unused corner, and put under the direction of a foreman who did not know how to operate it. Other degreasers were later added to the plant, each placed under the supervision of a different department. The results depended up the luck of finding a good operator who would keep his machine in good condition and do his work reliably. He cleaned it when he thought it necessary, or when he had a slack hour.

This turned into confusion. No one was responsible. Machines were constantly breaking down. Once in a while one would become short-circuited and the oil in the tank catch afire. Neighboring machinists got up a petition to have the degreasers removed from the plant. Service men from the manufacturing company did all they could. It was a headache to

the master mechanic. The consumption of a solvent was so large that the factory was about ready to go back to soda kettles.

This bad situation was soon cured. In one plant it came gradually. One operator had been working for about a year on an immersion type machine. He had complete charge of it. It worked well and was never out of repair. When something went wrong he fixed it himself. There was no one in the plant who knew anything about degreasers beyond casual observation. Being interested in his work he determined to be the plant authority on degreasers. He went to two engineering schools and talked with professors. He read every article or booklet on the subject he could lay his hands on. He pumped salesmen, service men, plumbers, electricians and chemists for information. The result was that when another degreaser in the plant needed special attention he would be sent to repair it. Finally a new arrangement was set up putting him in charge of all degreasing machines night and day. He saw that all machines were running satisfactorily at all times and that work was done as it should be. Soon the headaches disappeared, neighboring operators stopped complaining, and plant officials forgot they had any degreasers.

This is the easiest solution. Put a trained operator in charge of all degreasing machines. Give him opportunity to learn the routine and needs of each machine. Let him supervise the cleaning (which should be done by the same man each week), have the right to shut down any machine he requires, and keep all machines in running order. Then there will be few troubles or complaints.

There are five main responsibilities of the chief operator. The first is toward the men under him. Good operators are absolutely essential. They must be broken in by the chief operator, taught to know their machines, to do satisfactory work and guard their own safety. They must know the nature of the solvent. They must be quick to recognize anything wrong with the machine. They must cooperate with the foremen from whom they get their work and to whom they send it. They must be "good housekeepers." They must be provided with plenty of leather gloves, hooks, baskets and other necessities.

At first operators were selected from older men who were tired of sweeping floors. It was enough to show them how to operate the hoist and how to put the basket into the vapor and take it out. Now it is rec-

ognized that the operator should be as strong, alert and intelligent as any other machinist. It takes as long to be a good operator on a degreaser as to break in a raw workman on a turret or milling machine. He should be given good equipment. One bad case of rust was traced back to dirty gloves. He should be encouraged to handle his work carefully. Gear teeth are easily marred, and scratches may spoil precision, particularly where high accuracy is demanded.

The job of the operator of a degreasing machine should be recognized as essential and respectable. It ought to be well paid, so that the operator will have an incentive to take greater interest in his work. Sometimes he needs help. Frequently he needs special encouragement. The chief operator can absorb his headaches and give him the cooperation he needs.

His second responsibility is the degreasing machine. He must know each one. He must know how to operate them and what is required of them. He must see that they are cleaned so regularly that they are always free from dirt, rust and water. Some need to be cleaned every two or three days and some once a week. It must be done on schedule. If the machine accumulates too much acid a soda bath may be necessary. He must know what to do and be willing to get dirty.

The machine must be repaired at necessity promptly. It must be kept filled with solvent to a proper level. The thermostats must be properly set and regulated. There must be an adjustment of the water used through the coils or jackets to the humidity in the air. Typical repairs are to hoists, wiring, coils (which burn out like light bulbs), pumps, air hose, hooks, baskets, faucets or gages. A rusty machine may be re zinced.

The third responsibility is for cleaning the machine. This must be done regularly, as often as accumulated sludge demands. Most solvents

will still clean when dirty. But it is harder on the operator and more liable to start rust. In cleaning, the solvent is distilled in the machine as far down as the coils permit. If the residue is taken out with an electric pump it will cause less trouble. The sludge contains solvent plus the oil from cleaned material. The still pays for itself in a short time in solvent saved. A further argument for a still is that the solvent saved will titrate higher than the original solvent, and is a life-saver in rust prevention—one of the other headaches in all steel plants. The still is simple to operate. In fact a small sized immersion type degreaser answers the purpose. The boiling point should not exceed 260 deg. F. And, do not try to pour cold sludge into boiling liquid.

The coils must be taken out of the lower door so that all carbon can be removed from them and the floor of the degreaser thoroughly cleaned. Sometimes a vacuum pump helps. Generally it is a job for a broom and a hoe. Proper gaskets, well lubricated, must be replaced to avoid leaks, and the machine put back into working condition. This operation may require from 1½ to 5 hr. The immersion type takes longer. The work may be speeded up by pumping all solvent from the machines and doing all distilling at the still. The most important item is to have a regular calendar for cleaning and a constant check to see that it is done right.

A fourth responsibility is the avoiding of rust. What is its cause? Where does hydrochloric acid come from? How did the water get into the machine? Humidity is most unwelcomed in a steel plant. There are two months in each year when it is especially troublesome. Some men's hands are so oily that a piece of steel they touch at night will be rusty the next day. Pans of machined parts may rust in a day. The water in the air, the moisture from pipes, a leaky water pipe, rain through a window, any of a number of things may cause

corrosion. A near-by foundry sends off acid into the air that eats the copper roofing. It is in the air. A strange acid may be found to come from a woolen mill far up-stream. The causes have to be studied. It is less expensive to have rust prevention than rust removal.

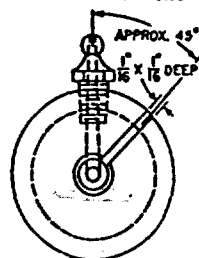
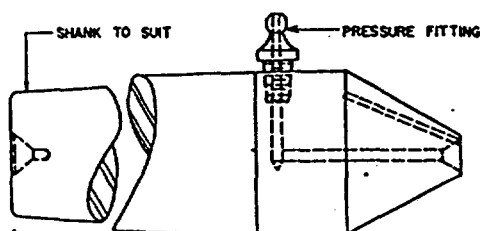
If there is rust in a degreaser it may spread to the work it is supposed to clean. One machine rusted from excessive water. Service men could not find the leak. They washed it out completely with soda water. It still contaminated the work that went through it. Finally a leak in a water pipe was discovered, corrected and the trouble stopped. Pipes drip water on humid days. Moisture accumulates. The amount of water run through the coils must then be cut down, and the water in the machine, not otherwise taken out by the water separator, removed. A chamois skin dipper works easily. Machines must be neutralized if an acid condition exists. Some solvents do not take aluminum or magnesium, and acid may result. The easiest and surest test for rust resistance is to titrate samples of distilled solvent from each machine. If this is done regularly once a week, or on suspicion, there is positive evidence as to the presence or absence of acid. If the score of each machine is kept for a few months, and the average per cent of rust resistance known, there is no guesswork as to how the machine is running. If the per cent is low it may be built up with fresh solvent or with "super solvent" from the still.

The fifth responsibility is for the consumption of solvents. If this is not watched the whole job might be considered a luxury. In one shop the average of 3 gal. per day per machine for the immersion type and 5 gal. for the vapor type were established. These were medium sized machines. It was reduced 20 per cent by using the still and almost 10 per cent by careful supervision.

## Lubricated Lathe Center

A SPECIAL lubricated lathe center devised at General Electric's Pittsfield Works prevents shaft centers from "picking up" when machin-

ing heavy shafts. Lubricant is introduced into the hole in the center of the shaft by a pressure gun through a fitting on the shank of the lathe



center. It is forced into the shaft center and when full it is indicated by exuding along a 1/16 x 1/16 in. groove on the outside of the lathe center. As the shaft turns, the lubricant is wiped against the shaft center. The groove is positioned where there is low pressure between the machine center and the shaft center. This obtains the best possible adhesion of the lubricant to the shaft center.

With this arrangement, the shaft center can be lubricated while a cut is being taken.